REMARKS

The Applicants have carefully considered this application in connection with the Examiner's Action and respectfully request reconsideration of this application in view of the following remarks.

In a telephone interview with the Examiner on November 29, 2006, the Examiner was asked if the return of language removed from the Claim 1 in a preliminary amendment filed September 1, 2006 would result in allowable subject matter. The Examiner indicated that it would not. The Examiner offered no suggestions of a claim amendment that would result in allowable subject matter. In the present response, the claims have not been amended. Therefore Claims 1-5, 7, 9-12, 14-20, 22, 24-26, 28 and 30-34 are currently pending in the application.

I. Rejection of Claims 1-5, 7, 9-12, 14-20, 22, 24-26, 28 and 30-34 under 35 U.S.C. § 103

Claims 1-5, 7, 9-12 and 14-18 are rejected under 35 U.S.C. § 103 as unpatentable over U.S. Patent No. 4,845,043 to Catalano ("Catalano") in combination with U.S. Patent No. 5,620,559 to Kikuchi ("Kikuchi"), U.S. Patent Publication No. 2004/0043570 to Fujisaki ("Fujisaki"), U.S. Patent No. 6,492,283 to Raaijmakers, et al. ("Raaijmakers"), and U.S. Patent No. 6,350,322 to Yates (Yates). Claims 19-20, 22, 24-26, 28 and 30-34 are rejected under 35 U.S.C. § 103 as being unpatentable over Catalano in combination with Kikuchi.

The Applicants submit that the asserted combination of Catalano, Kikuchi, Fujisaki, Raaijmakers and Yates, or of Catalano and Kikuchi fail to establish a *prima facie* case of obviousness because these combinations are improper.

1) Catalano and Kikuchi are not a proper combination

The Examiner argues that it would be obvious to supply hydrogen as taught by Kikuchi in Catalano's process to enhance and improve the removal process (Examiner's Detailed Action, Items 5 and 9).

The Applicants disagree because there is no basis in the art to combine these references.

For instance, Catalano's process is directed to removing p-layer dopant contaminants from a chamber (Catalano, Column 2, Lines 10-14; Column 5, Lines 1-4), while Kikuchi's hydrogen plasma process is directed to removing a native oxide film on a silicon chip (Kikuchi, Column 5, Lines 33-38).

Catalano discloses fabricating a silicon p-layer in a single glow discharge deposition chamber batch system by introducing diborane (B_2H_6) gas into a mixture containing silane in the chamber (Catalano, Column 1, Lines 42-50; Column 4, Lines 45-49). Catalano further states,

> in a single glow discharge deposition chamber system where the internal chamber surfaces including the cathode are coated with the p-layer material, susbsequent [sic] depositions may sputter boron off the chamber walls to contaminate the undoped i-layer. (Catalano, Column 2, Lines 10-14)

Catalano proposes a process to remove the residual boron by reacting the diborane gas with nitrogen trifluoride gas to produce boron trifluoride gas and then pumping the gases away from the chamber prior to depositing the i-layer (Catalano, Column 2, Lines 15-24).

It is not apparent to the Applicants what motive one of ordinary skill in the art would have to apply Kikiuchi's hydrogen plasma process to Catalano's process, which is directed to removing residual boron. For instance, the Examiner has not cited any portions of Kikiuchi that discloses Kikiuchi's hydrogen plasma process to be effective at removing p-layer dopant contaminants. Nor

has the Examiner cited any portions of Catalano that discloses the desirability of removing a native oxide from his p-layer. The Applicants submit that Catalano's process for forming a photovoltaic cell would have no such motivation, because Catalano discloses flushing his chamber with a decontamination gas immediately prior to depositing the i-layer (Catalano, Column 6, Lines 45-50). Therefore there would be no opportunity for an oxide layer to form prior to depositing the i-layer. Moreover, the gases Kikiuchi uses to produce his hydrogen plasma (H_2 and H_2O; Kikiuchi, Column 4, Lines 40-44) are not among the extensive list of decontamination gases cited by Catalano (Catalano, Col. 6, Lines 39-43).

Additionally, Kikiuchi specifically teaches away from the combination proposed by the Examiner. Kikiuchi states,

> The experimental results were not good when NF_3 gas was introduced into the H_2 + H_2O gas at a region where plasma is generated or still resident. For this reason, the additive gas introducing system 6 was connected to the system at a position downstream from the plasma generating region 44 by about 20 cm (Kikiuchi, Column 4, Lines 53-58, emphasis added).

Thus, Kikiuchi teaches away from supplying Kikiuchi's hydrogen plasma process gases in Catalano's chamber decontamination process which uses NF_3 gas.

Therefore the combination of Catalano with Kikiuchi is improper because a person having ordinary skill in the art would not be motivated to find or add to Catalano the teachings and suggestions of Kikiuchi and because Kikiuchi teaches away from the combination as applied in the Office Action.

2) Catalano Kikuchi and Fujisaki are not a proper combination

The Examiner argues that it would be obvious to adjust the time, temperature and flow rate of Catalano's nitrogen-containing gas to improve the removal process, and to use the hydrogen termination and the depositing temperature taught by Fujisaki in Catalano's process to improve the cleaning process (Examiner's Detailed Action, Item 5).

Again the Applicants disagree because there is no basis in the art to combine these references.

As noted in (1) above, Catalano's process is directed to removing p-layer dopant contaminants from a chamber. In particular, Catalano discloses flushing his chamber with a decontamination means (e.g., NF_3 gas) for substantially removing residual p-layer doping contaminants in a gaseous state (Catalano, Column 5, Lines 1-4). Catalano further states,

> The deposition chamber is preferably flushed for about 10 minutes at a gas flow rate of 100 sccm and 0.5 torr. The substrate temperature is preferably 250°C, although temperatures typically range between 200°-300°C. (Catalano, Column 5, Lines 12-16)

Catalano's temperature range is in contrast to Kikuchi, who discloses heating a silicon chip to 60°C or higher, 80°C or higher, or heating to a temperature of 100°C (Kikuchi, Column 8, Lines 4-20). E.g., Kikuchi states, "By-products can be removed in a short time by raising a temperature to about 80°C." (Column 8, Lines 18-20).

Both of the non-overlapping temperature ranges disclosed in Catalano and Kikuchi are still further in contrast to Fujisaki, who discloses removing hydrogen atoms at a silicon substrate surface by heating the substrate to 560°C or higher. E.g., Fujisaki states,

> When the Si substrate subjected to the hydrogen termination is heated, at 560°C or higher, hydrogen atoms at the surface are evaporated and the silicon nitride film which does not include Si–H bonds is formed (Fujisaki, paragraph [0045]).

Fujisaki further discloses that the formation of a silicon nitride film that does not include Si–H bonds is important to improving the heat resistance of the silicon nitride film when used as a transistor gate insulator layer (Fujisaki, paragraph [0004] and [0012]).

It is unclear to the Applicants what motive one of ordinary skill in the art would have to apply Fujisaki's disclosure of substrate heating to 560°C or higher to Catalano's process to remove residual boron from a deposition chamber, or to Kikuchi's process to remove by-products. The Applicants submit that there is no such motivation because Fujisaki uses such temperatures to ensure the absence of hydrogen from a silicon nitride film, and not to improve the removal of p-layer doping contaminants from a deposition chamber, or to remove Kikuchi's by-products. Moreover, it is clear that the by-products removed by Kikuchi's heating are not the hydrogen terminations on a substrate, because Kikuchi discloses FT-IR data showing peaks that correspond to Si–H bonds after Kikuchi's heating of the silicon chip (Kikuchi, Column 5, Lines 29-34; Fig. 7A). Rather, Kikuchi's by-products have an absorption peak at 3200 to 3600 cm^{-1} (Kikuchi, Column 4, Lines 44-61; Fig. 6A) and they are shown to be effectively removed at the much lower temperatures disclosed by Kikuchi (Kikuchi, Fig. 6B).

As such, there is no demonstrated recognition in the art that adjusting to a temperature of 560°C or higher is a result effective variable in the decontamination of p-layer dopants from a deposition chamber or the removal of Kikuchi's by-products.

Moreover, Fujisaki's temperature appears to teach away from the temperature ranges taught by Catalano and Kikuchi. Catalano and Kikuchi, in turn, teach away from each other's temperature

ranges, and both Catalano and Kikuchi teach away from the temperature range recited in Claims 1 and 19.

Therefore, the combination of Catalano, Kikiuchi and Fujisaki is improper because a person having ordinary skill in the art would not be motivated to find or add to Catalano the teachings and suggestions of Kikiuchi or Fujisaki and because these references either teaches away from the each other, or from independent Claim 1 and 19.

II. Conclusion

For the foregoing reasons, applicant respectfully submits that the foregoing claims, as amended, are allowable. Therefore, a Notice of Allowance for Claims 1-5, 7, 9-12, 14-20, 22, 24-26, 28 and 30-34 is respectfully requested.

Should it facilitate allowance of the application, the Examiner is invited to telephone the undersigned attorney. The Commissioner is hereby authorized to charge any additional payment that may be due or credit any overpayment to Deposit Account No. 08-2395.

Respectfully submitted,

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